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CENTRAL INTELLIGENCE AGENCY

INFORMATION FROM

FOREIGN DOCUMENTS OR RADIO BROAD

CONFIDENTIAL

50X1-HUM

COUNTRY USSR

SUBJECT Scientific -- Automobile engines and fuels

HOW PUBLISHED Monthly periodical

WHERE PUBLISHED Moscow

DATE PUBLISHED May 1947

LANGUAGE Ru Russian

THIS

SOURCE Avtomobil', No 5, 1947. (FDB Per Abs 12T21 --

THE QUALITY OF GASOLINE FOR USE IN NEW MODEL CARS

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One of the most important problems of automobile construction is improving the economy of the engine and increasing its durability and reliability in use. This is indissolubly linked with the quality of fuel used.

The most effective improvement in engine economy is attained by increasing its compression ratio. This is borne out by the results of bench tests of the GAZ-AA and GAZ-MM engines with increased compression ratios (Table 1).

Table 1. Decrease in Minimum Specific Gasoline Consumption in GAZ-AA and GAZ-MM Engines With Increased Compression Ratios

Compression Ratio	GAZ-AA				GAZ-MM		
	4.2	5.3	5.8	6.5	4.6	5.5	5.7
Decrease of minimum specific consumption %	0	11.7	16.7	19.6	0	10.2	14.5

The throttle characteristics of the GAZ-AA engine with the same compression ratios give a still greater economy (Table 2).

Table 2. Average Gasoline Saving According to Throttle Characteristics of GAZ-AA Engine With Increased Compression Ratios

Compression Ratio	4.2	5.3	5.8	6.5
Gasoline saving in % at 1,500 rpm	0	16.1	15.8	16.5
Gasoline saving in % at 2,000 rpm	0	14.3	18.2	17.6

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Road trials are in full agreement with the results of bench tests. The GAZ-AA automobile gave gasoline savings of 7.4 percent and 9.9 percent when compression ratios were increased to 5.3 and 6.5. When the compression ratio of the GAZ-MM engine was increased to 5.3, gasoline consumption was decreased by 5.2-5.3 percent and when the compression ratio was increased to 6.4 consumption was decreased by 10-10.3 percent. This increase in engine economy was attained on ethyl gasoline with an octane number of 72-73.

The above data demonstrates the absolute practicability of increasing the compression ratio of an engine, which is possible only when running on gasoline with a fairly high octane number.

The new model domestic automobile have engines with an increased compression ratio and are in all respects the equal of the best American automobile (Table 3). Therefore, gasoline with an octane number of at least 70 is required for the GAZ-51, Pobeda, and Moskvich automobiles, and at least 74 for the ZIS-110.

Table 3. Basic Characteristics of New Automobile Engines

Engine	No of Cylinders	Cylinder Diameter (mm)	Piston Stroke (mm)	Capacity (liters)	Compression Ratio	Max Power HP	Max Power rpm	Min Specific Consumption of Gas (grams/ effective HP hr)
ZIS-110	8	90	118	6.0	6.85	140	3,600	270
Pobeda (GAZ-20)	4	82	100	2.12	6.2-6.5	50	3,600	265
Moskvich	4	67.2	75	1.1	6.0	23	3,400	310
GAZ-51	6	82	110	3.48	6.2	70	2,800*	270

* With governor

In this connection the trials of the GAZ-51 and Pobeda automobiles carried out at Gor'kiy auto plant are significant. Experimental running of these automobiles on 55-octave gasoline proved practically impossible.

Increase of engine economy is closely interallied not only with the octane number of the gasoline but also with its fractional composition.

Gasoline containing the relatively light fractions and with a low distillation range evaporates better during the formation of the operating mixture and condenses in the engine to a lesser extent, especially at small loads and varying revolutions (i.e., under operating conditions). The 50 percent and 90 percent evaporation temperatures of a gasoline and its final boiling point are criteria of fractional composition which determine the gasoline from the economy and engine durability.

The effect of these figures on economy and engine durability has been proved by many trials on heavy and winter gasolines. The fractional composition of these gasolines is shown in Table 4. The fractional compositions of the standard gasolines have been given for purposes of comparison.

Table 4. Fractional Compositions of Heavy, Winter, and Standard Gasolines (According to Analysis Data)

Fractional Composition	Heavy (1943)	Standard (1943)	Winter (1940)	Standard (1940)
Initial boiling point °C	72-85	58	--	43
10% evaporation at °C	104-110	87	74	85
50% " " °C	163-176	175	136	150
90% " " °C	233-240	230	186	215
Final boiling point °C	259-260	over 235	200	225

Road trails of GAZ-AA and ZIS-5 automobiles using heavy gasoline showed an increase of consumption 14.7 and 18.3 percent, respectively, as compared with 1943 standard gasoline. During trials on winter gasoline, as compared with 1940 standard gasoline, a saving of 3 percent was obtained with the KIM-10 automobile and 4.8 percent with the GAZ-MM automobile.

No less significant were the bench trials of an engine similar to the ZIS-110 which used two kinds of imported gasoline with the same octane numbers (around 70) and final boiling point (186-187 degrees centigrade) but different temperatures of 50 percent (by 5 degree centigrade) and 90 percent (by 10 degrees centigrade) evaporations. Consumption of the lighter gasoline was 2-5 percent less.

The use of heavy gasoline not only increases consumption but leads to excessive dilution of the oil in the crankcase of the engine and washing the lubricant off the cylinder walls, all of which cause increased wear of cylinders, piston rings, and other engine parts.

A comparison of the amounts of war observed in the ZIS-5 engine (after 10,000 kilometers) using 1940 heavy and standard gasolines (with a final boiling point of 225 degrees centigrade) shows that the heavy gasolines quintuples cylinder wear, doubles piston wear, and triples that of the connecting rod journal of the crankshaft.

Micrometer readings of the GAZ-MM engine after trials with winter gasoline showed, on the other hand, a decrease in wear, as compared with the readings obtained after using 1940 standard gasoline. The cylinder wear was decreased by two fifths, that of the piston ring (by weight) by five eights and that of the connecting rod journal of the crankshaft by two thirds.

Moreover, a lower final boiling point decreases oil expenditure. This was very clearly demonstrated during trials of winter gasolines used in the GAS-MM automobile, which showed a 23 percent decrease in oil consumption as compared with standard gasoline.

From the data quoted, it is evident that the use of gasoline with a heavy fractional composition in the new automobile models with high-output engines is not permissible.

The presence of light fractions, characterized by the 10 percent evaporation temperature, in a gasoline is of great significance. Light gasoline fractions ensure easy starting and rapid warming of the engine, which is especially important [illegible] automobile operation in winter conditions and in the northern regions of the USSR. Starting and warming the engine on gasolines without a sufficient quantity of light fractions results in an overrich mixture (due to use of the choke), and this causes increased engine wear.

During trials on heavy gasolines, starting of GAS-MM and ZIS-5 engines at an air temperature of + 5 degrees centigrade was possible only after heating the intake manifold. The engine did not warm up until it had run "on the choke" for about 20 kilometers. When winter gasoline was used, starting at an air temperature of -16 degrees centigrade was 2.3 times faster than with 1940 standard gasoline, and at a temperature of +6 degrees centigrade, 1.5 times faster. The engine revolutions and gasoline consumption on starting were decreased about two third in both cases. Trials of the ZIS-5 engine using winter gasoline at a temperature of -3 degrees centigrade showed that starting time was shortened by one fifth, the number of a revolutions before the first explosion was decreased by four sevenths, and the gasoline consumption lowered by approximately two thirds.

In this connection, the experiments on starting an engine similar to the ZIS-110 at a surrounding air temperature of + 6 degrees centigrade are of particular interest. The experiments were carried out on two types of gasoline, with 10 percent evaporation temperatures of 97 degrees centigrade and 69 degrees centigrade respectively.

In the first case, the starting time was increased 1.6 times, the number of crankshaft revolutions before the first explosion increased 1.8 times, and the fuel expenditure 2.3 times.

The fact that most automobiles, in the USSR are not kept in garages, the running conditions of light automobiles and, especially, the demands for autotransport mobility in military freightage, preclude the use of gasolines with low light-fraction contents. It must also be remarked that when heavy-fraction gasolines are used the power of the automobile decreases. Consequently, economy decreases especially under city driving conditions.

At present, automobiles of all types, except the ZIS-110, are supplied with gasoline in accordance with GOST 2084-46. The fractional composition of this gasoline does not ensure easy starting, and causes excess fuel consumption and premature engine wear. The absence of a fixed octane number in the specification results in the petroleum refineries producing gasolines with octane numbers of 55-65 and even lower. This makes it necessary to retard the spark, i.e., to run uneconomically.

The operation of automobiles under various climatic conditions involves supplying them with a minimum of three kinds of gasoline: winter for use in winter time (in northern regions, all the year round); summer, for use in summer time (in southern and central zones of the Union); and special for use in high-power light automobiles (types ZIS-110).

These types of gasolines should have the fractional composition shown in Table 5.

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Table 5. Fractional Compos[illegible]ion of Winter, Summer and Special Gasolines

Fractional Composition	Winter	Summer	Special
10% evaporation at °C	70-73	80-85	68-70
50% " " °C	135-140	145-150	100-105
90% " " °C	185-190	195-200	160-165
Final boiling point °C	195-200	205-210	175-180

There should be two gra[illegible]es of winter and summer gasolines: one with an octane number of 65, the other with an octane number of 70. For gasolines other than special, addition of ethyl fluid (R-9) is permissible in the proportion of 1.0-1.5 milligrams to 1 kilogram of gasoline. This amount is quite sufficient to raise the octane number of most gasolines produced in the USSR to the necessary figure.

Seventy-octane gasoline is intended for new automobile models (except ZIS-110). In the absence of 70-octane gasoline, they can be run on gasoline with an octane number of 65, although less economically. At the same time 65-octane gasoline enables the compression ratio of the old GAZ-MM and ZIS-5 models to be increased by replacing the cylinder head. This measure can be carried out for the existing stock of automobiles during overhaul. However, gasoline with an octane number of 65 should be regarded as an interim substitute for gasoline with an octane number of 70.

Special gasoline should have an octane number of around 74-75. Addition of ethyl fluid to this gasoline is not permissible as the engine for which it is intended operates under high temperature conditions. The special gasoline (GOST 3291-46) produced by the petroleum industry satisfies the demands required of gasoline for the high-power engines like those of the ZIS-110 light automobiles. (See author's article, Avtomobil', No 3 1947.)

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